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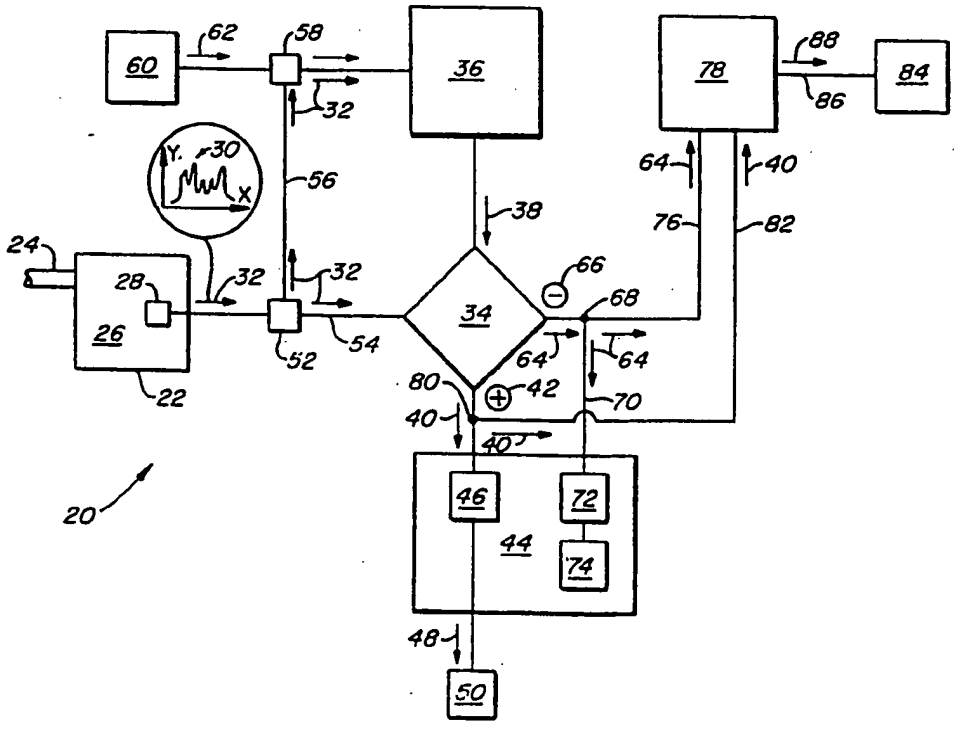
(54) Title: SYSTEM FOR BREATH SIGNATURE CHARACTERIZATION

(57) Abstract

Apparatus (20) and method for generating a breath signature signal (32) for a person who delivers a breath sample to a breath sampler (22). A transducer (28) is communicated with the breath sampler (22), for sensing at least the temperature, the pressure and humidity of the breath sample. In response, the transducer (28) generates a breath signature signal (32) which distinguishes one person from another. The breath sample can be tested (a) for validity, (b) for distinguishing it on the basis of sex and age, (c) for selecting whether or not the same person delivered two different breath samples, and (d) for recognizing the identity of a particular person giving two different breath samples. Additional features include breath references (36, 36A-D, 38, 38A-D, 62), comparators (34, 34A-D), a distinguisher (34B), a selector, (34C), and a recognization means (34D).



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SYSTEM FOR BREATH SIGNATURE CHARACTERIZATION

TECHNICAL FIELD

The field of this Invention relates generally to systems, both apparatus and method, for characterizing breath samples of humans. More specifically, this Invention relates to systems employing a person's breath sample to develop a breath signature signal; this signal can then be used to (a) identify characteristics of the person and (b) detect the presence of drugs in the breath sample, particularly alcohol.

BACKGROUND ART

Although various schemes have been devised for analyzing human breath samples in order to obtain information about a person, particularly information relating to the person's percent blood alcohol concentration (BAC), there continues to be shortcomings and deficiencies in the technology. Specifically, existing breath analysis techniques simply do not provide approaches for gathering information other than BAC about the person from a breath sample. Examples of existing technology are discussed below.

U.S. Patent 4,093,945 to Collier et al discloses a breath testing system for alcohol intoxication breath testing. The system includes (a) a breath input unit, (b) a controller which delivers a sample of deep lung breath to (c) an evaluator including an alcohol detector and an output apparatus. The controller includes a breath flow sensing means to insure that a deep lung breath sample is tested. A passing signal cannot be obtained unless (a)

the predetermined continuous and uninterrupted flow has occurred, and (b) the resulting sample tests below a predetermined alcohol concentration.

U.S. Patent 4,316,380 discloses a system for determining the alcohol content of the breath of a test person. The system (a) measures the alcohol content of the breath to produce an alcohol content signal, (b) measures the change in the alcohol content signal, (c) measures a flow of the breath of the test person, and (d) indicates the alcohol content using the alcohol content signal only when the change in the signal per unit time is below a pre-selected change value and the flow is above a pre-selected flow value, and further where the flow has not dropped below the predetermined flow value since it first reached the predetermined flow value.

U.S. Patent 4,317,453 to Heim et al discloses a system for testing a person's breath for the determination of its alcohol content. The system first determines when the breathing air is at a condition in which breath testing results will be effected. This is done by arranging a capacitor in a breathing tube through which the breathing air is directed.

First the capacitor is heated to a predetermined temperature, and then the breathing air is directed over it so as to cool the capacitor until it has attained a predetermined temperature change. This temperature change is such that it will take place when a person's breathing air has its desired consistency.

When this occurs, the breathing air is then directed into a test chamber, in which it is tested to determine the constituency of the breathing air, particularly the percentage of alcohol which it contains. A device for testing a person's breath, in addition to the tube through which the breath is directed containing the thermal capacitor, also contains a test chamber which is connected to the tube with control means, which senses the temperature of the capacitor and permits the flow of the gas into the test chamber only after a predetermined temperature drop has taken place.

U.S. Patent Application having Serial Number 06/494,301, filed May 13, 1983, by Brian P. Elfman and Lawrence T. Rojahn, now abandoned, discloses an apparatus for measuring the blood alcohol concentration (BAC) of an individual. The apparatus includes a gas vapor sensor for receiving and analyzing the alcohol concentration

vapor sensor for receiving and analyzing the alcohol concentration in the breath of the individual, an analog-to-digital converter, and a gas analyzer for detecting the rate of change of the signal generated by the sensor. When the signal rate of change is at or near zero, thereby indicating the breath is deep lung air, the sensor signal is transposed to a blood alcohol concentration reading in the BAC look up table, and then compare to a pre-recorded level obtained from a memory, to determine the intoxication level of the individual. A flow sensor can be provided to assure that the individual is expelling a sufficient volume of air to assure a good reading. An auto ignition gate can be provided to disable a vehicle if the individual is found to have a BAC reading above a predetermined level which indicates intoxication.

While the above printed publications do offer laudable approaches and solutions with respect to the particular situation each addresses, none of them individually or in a combination disclose or suggest the invention defined in the appended claims of this present case. Specifically, the following problems persist despite the efforts of the existing technology.

All the above approaches are specifically directed to determining the BAC of a person in order to prevent that person from operating a vehicle if he is inebriated. No additional information can be determined by these systems from the breath sample. These systems are not sophisticated enough to accurately and reliably identify a particular person, or select a specific person out of a group of persons, or specify a person's sex and age.

Existing breath analyzing equipment, to provide a breath sample test result which can be introduced into evidence in a drunk driving prosecution, must be built to very precise specifications, are large and not easily transportable, and are sensitive and thus require frequent servicing in order to remain precisely calibrated. As a result, the available equipment is quite expensive. Because the accurate equipment is not easily transportable, an arresting police officer faces a race against time in getting an inebriated person to the equipment's location quickly enough that a person's body does not metabolize the alcohol prior to a BAC test. Additionally, these systems have difficulty in accurately detecting attempts to deliver bogus breath samples to them, for example in case where an

inebriated person #1 has a breath sample delivered by a sober person #2. The opportunity also exists to introduce a bogus breath sample originating in a compressed air bottle or having been filtered prior to being subjected to a BAC test.

These are only a few of the problems which have not been adequately resolved by the existing technology. Because of these problems, it became necessary to devise the Invention (1) disclosed by example below, and (2) defined in the appended Claims.

DISCLOSURE OF THE INVENTION

Solutions and advantages are offered by this Invention which resolve many of the deficiencies still existing in the current technology.

Broadly summarized, this Invention provides a system, both apparatus and method, for generating a breath signature signal for a person who delivers a breath sample to a breath sampler means. The apparatus comprises a transducer means, communicated with the breath sampler means, for sensing at least the temperature, the pressure and the humidity of the breath sample, and in response generating a breath signature signal which distinguishes the person from a plurality of persons.

Additional features include apparatus and methods wherein: (a) the breath sample is a deep lung breath sample; (b) the breath signature signal comprises a frequency spectrum generated by the integration of at least the temperature, the pressure and the humidity of the breath sample; and (c) the integration is performed by the transducer.

Further included is a validifier means for determining that the breath sample is delivered unaltered to the breath sampler. The validifier means first comprises a valid breath reference means, for representing the valid common range of values of at least the temperature, the pressure and the humidity of the typical breath samples taken from a reference population of persons. The validifier means second comprises a comparator means, coupled to the valid breath reference means and the transducer means, for comparing the breath signal against the valid breath reference means to determine if the breath sample is valid.

Still another provision provides for a distinguisher means for

distinguishing , with respect to the person, both of (a) a male from a female, and (b) a child from an adult. The distinguisher means first comprises a separate class reference means for each of at least a group of four separate classes comprising respectively a plurality of males, females, children and adults. The class reference means contains at least the ranges of the temperatures, the pressures and the humidity of the typical breath samples characteristic of each of the classes. The distinguisher means second comprises the distinguisher means being coupled to the comparator means for comparing the class reference means with the breath sample of the person, to identify the person as being both (1) one of a male and a female, and (2) one of a child and an adult.

Another option includes a selector means for determining if a later breath sample was delivered by the same person who delivered an earlier breath sample, the selector means being communicated with the breath signature signal of both the earlier breath sample and the later breath sample, for comparing the breath signatures to see if they are the same, to thereby indicate that the same person one of (a) did and (b) did not deliver both breath samples.

Also included is a recognition means for providing a positive identification of a person delivering a breath sample in the future.

The recognition means first comprises a personal identification reference means, created by recording a specific breath signature signal produced by the transducer means in response to a specific breath sample delivered in the present by each of a group of specific persons who are to be identified in the future according to the specific breath sample to be given in the future by each of the specific persons.

The recognition means second comprises the comparator means being communicated to the personal identification reference means and the transducer means, for comparing each of the specific breath signature samples to the values stored in the personal identification reference means, to confirm one of (1) the same person delivered both of the present and the future breath samples, and (2) the same person did not deliver both of the present and the future samples.

Another feature adds a sensing means, communicated to the breath sampler means, for detecting the presence of a drug in the

breath sample, including a drug which is an alcohol.

This Invention begins and takes off from the point where the existing technology ends, by greatly expanding the technology of breath sampling, to thereby permit the acquisition of new and more sophisticated information about the person giving the breath sample.

A key feature and advantage of this Invention is that, on the basis of a single breath sample from a particular person, a breath signature signal can be generated which is unique for that particular person. Once this breath signature signal is stored in some form of memory device, future breath samples generating future breath signature signals can be compared against the stored signal.

This is a very important technological breakthrough. This breath signature signal can be used in (a) establishing the validity of a breath sample, (b) distinguishing a person's sex and age on the basis of the sample, (c) selecting among a group of persons to see if two breath samples came from the person, and (d) recognizing the identity of the particular person delivering the breath sample.

The plural apparatus and method of this Invention employs a simple, sophisticated and inexpensive transducer to measure the temperature, pressure and humidity of a breath sample. The transducer then integrates these values together to produce a single output breath signature signal in the form of a frequency spectrum unique to the person delivering the sample. The frequency spectrum is then stored and used as a reference template against future breath samples.

The existing technology requires complex apparatus to measure temperature, pressure and/or temperature and pressure together; these values are then manipulated by complex mathematical formula to obtain information about the breath sample. Complex flow meters are used to insure delivery of a deep breath sample. The only value measured is the BAC, and that is measured with a chemical sensor. In contrast, this Invention performs a simple joint measurement of temperature, pressure and humidity combined, integrates this measurement, and produces as an output the breath signature signal.

The apparatus of this Invention is rugged, accurate, reliable, easily calibrated and supplies breath sample information that can be

used by the prosecution in a drunk driving adjudication. When installed in a vehicle and interlocked into the vehicle's ignition system, it would be impossible for an inebriated person to start the vehicle.

Additional features and advantages offered by this Invention are (1) described by example below, and (2) defined in the appended Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram which shows the apparatus and method of this Invention;

Table I, entitled "Determinations re Breath Samples", summarizes the information this Invention can obtain from a breath sample;

Figure 2 is a schematic drawing showing the voice creating sub-systems of a human body;

Figure 3A and 3B illustrate two different breath signature samples in the form of two different frequency spectrums in response to breath samples and other human sounds created by the Figure 1 schematic;

Figure 4 is a more detailed schematic of the apparatus and the method of this Invention.

BEST MODE OF CARRYING OUT THE INVENTION

This Detailed Description, which incorporates the accompanying Drawings briefly described below, offers specific examples (i.e., embodiments) of how to practice the Invention, but it does not actually define the Invention. Instead, the Invention is defined by the numbered paragraphs of the appended Claims. This Detailed Description sets forth the best modes presently contemplated by the Inventor for making and using the claimed Invention. Further, this Detailed Description is intended for facilitate, through example, the understanding of the Invention defined in the Claims.

Figure 1 illustrates an apparatus or system 20 for performing breath signature characterization.

A breath sampler 22 has a mouthpiece (not shown) communicated through a tube 24, for a person to deliver a breath sample into a chamber 26 defined within sampler 22. A transducer means

such as transducer 28 is communicated with breath sampler 22, in this case being mounted within chamber 26 in a conventional manner. Transducer 28 senses at least the temperature, the pressure and the humidity of the breath sample admitted into chamber 26. In response, transducer 28 generates a breath signature signal 30, also shown as the signal 32 arrow, which distinguishes the person giving the breath sample from a plurality of persons.

Signal 30 can then be compared in a comparator 34 with information stored in memory 36. If this information, in the form of a memory signal 38, is substantially similar to signal 32, comparator 34 generates an output signal 40 which says "ok" or "yes"; this output 40 leaves through the terminal indicated with a plus sign (+) enclosed in a circle, marked with a reference numeral as a positive response 42. Signal 40 enters an interlock 44 to activate and enable circuit 46, which generates a signal 48. This signal 48 passes into an ignition system 50 to enable ignition system 50 to be operated.

Additional apparatus and methods by this Invention further enhance its usefulness; these details are described below.

Signal 32 out of transducer 28 can be routed through a switch 52, to be routed unchanged as the signals 32 traveling through a line 54 into comparator 34, and a line 56. A switch 58 receives signal 56 and routes it unchanged into a recording device such as memory 36. The purpose of this approach is to provide a reference signal within memory 36 against which a future breath sample 32 entering comparator 34 would be compared.

However, other methods can be used for loading memory 36 with signals 38 for use by comparator 34 in comparing signal 32 against signal 38. For example, an input device, such as keyboard 60, can be used to feed reference signals 62 through switch 58 into memory 36. These signals 52 would emerge as signals 38 retrieved comarator 34 for comparison against breath signature 32. In this mode, switch 58 would be thrown to block signal 32 coming from line 56. However, in the mode described in the preceding paragraph, switch 58 is thrown to block signal 62 and admit signal 32.

If comparator 34 finds that signals 32 and 38 do not match, it generates a "not ok" or "no" signal; this is indicated schematically as a negative output 66 displayed as a negative sign (-) enclosed in a circle.

Signal 64 enters a junction 68, to emerge unchanged as indicated at the two additional arrows marked with reference numeral 64. One signal 64 feeds along a line 70 into a "not enable" block 72, which generates an end signal. This end signal is sent to a stop device 74 to not permit ignition system 50 to be operated.

The other signal 64 emerging from junction 68 travels along a line 76 unchanged into a storage device such as a memory 78 for recording. Likewise, the positive signal 40 passes unchanged a junction 80 to a line 82 into memory 78 for recording. Memory 78 provides a record of each test made so it can be later determined how many tests were conducted, What the results of the tests were, both in terms of the breath signature signal generated as well as whether there was a pass (as at reference numeral 42) or a fail (as at reference numeral 66), the time of day, the date and other information as desired. At a future time, an output device 84, coupled through a line 86 to memory 78, can retrieve a plurality of results 88 from memory 78. These results 88 will also include measurements of the percent BAC.

Table I shows the range of information this Invention can determine from a breath sample. Table I, located after this Detailed Description and preceding the Claims, is hereby incorporated by reference into this patent application.

The lowest level of information or robustness is in determining "validity" of a breath sample. The question is: has the breath sample been tampered with in order to permit the person to pass the breath test? Such alteration could be accomplished, for example, by passing the breath sample through a filter containing a desiccant in order to remove a drug such as alcohol. Removal of the alcohol or other drug by a desiccant will alter the humidity of the breath sample. This alteration will result in a breath signature signal which is not valid. Therefore, an ignition system could not be enabled.

With reference to Figure 1, the "validity" test would be accomplished by using an input device such as keyboard 60 to load reference values 62 into memory 36, these values 62 representing an average of the humidities, the temperatures and the pressures of breath samples from a reference population. The essence of this approach is to determine that the test breath sample signature sig-

or not valid. Another example of invalidity would be a blast of a pressurized gas from a gas bottle, which gas would not exhibit the same "breath signature signal" as would air expelled from a human being. A human lung breath sample will have a temperature, pressure and humidity which would be absent from a gas sample from a pressurized gas bottle.

The next higher level of information is the ability to "distinguish" both a person's sex and age from a breath sample. To accomplish this, memory 36 must be loaded with at least four separate tables representing the classes of breath samples from males, females, children and adults. This information most likely is loaded by way of keyboard 60, but it could also come from actually testing members from each of these four classes with sampler 22, which could be stored and averaged for each of the four classes.

Then, when breath signature signal 32 is generated by transducer 28, comparator 34 will compare signal 32 against each of the signals 38 for each of the four classes of males, females, children and adults. From this comparison, it can be determined what is the sex and age (i.e. child or adult) of the person delivering the breath sample.

"Select" is the next higher level of intelligence. The question is: is the person who delivers a breath sample in the future the same person who delivered a breath sample in the present? To accomplish this, memory 36 is loaded with a breath signature signal 32 produced by the particular person to be identified in the future. Then, at the future time, this signal stored in memory 36 is retrieved as signal 38 for comparison within comparator 34 with signature 32. This will give the result of saying that both breath samples came from the same person; however, this breath sample will not positively identify a particular person by name.

"Recognize" is the highest level of intelligence which can be determined by this Invention. The purpose is to positively identify the name of a person giving a future breath sample. To accomplish this, the breath signature signal 32 of every person to be identified in the future must be stored in memory 36. Therefore, in the present each person must generate a breath sample in sampler 22 which is then stored as a breath signature signal 32 in memory 36. At a future time, another breath sample is taken. Comparator 34

compares this new signal 32 against each breath signature signal stored in memory 36 until the identity of the specific person by name is produced.

Sounds such as voice and expelled breath produced by the human vocal system is a complex signal influenced by many facets of human physiology. As shown schematically in Figure 2, the human vocal sound system is influenced by a multiplicity of chambers and solid structures. Within a chest cavity 90 is at least one lung 92 powered by a diaphragm 94. To expel or exhale a breath sample, diaphragm 94 pushes upward in a direction 96, causing the air within lung 92 to move upward into lower wind pipe 98 through voice box 100, through an upper windpipe portion 102 into an intermediate chamber 104 which is generally designated as the pharynx.

The breath sample continues through mouth tube 106 into a branch region 108. At this point, the breath sample is divided so that some of it proceeds up a nose tube 110 into a nose chamber 112 and out through a nose port 114. The other portion of the breath proceeds form branch region 108 into a mouth chamber 116, to be expelled from a head 120 through a mouth port 118.

This human sound system 89, when expelling a breath sample through mouth port 118, generates a very complex sound. All of the just described chambers and structures of human sound system 89 has its own individual effect on this sound. The breath sample sound includes effects and characteristics resulting from the temperature, the pressure and the humidity of the breath sample.

According to this Invention, it has been found that the breath sample of each individual has its own unique characteristic temperature, pressure and humidity which effects the frequency spectrum of the range of frequencies of the sounds contained in the breath sample.

Figures 3A and 3B show two different curves 122 and 124, which are frequency spectrums typical of the kind that can be produced as a breath signature signal by this Invention, on the basis of a breath sample from a person. Each person produces varying amplitudes (the Y-axis) of frequency values as the frequency increases along the X-Axis. beginning at zero and moving toward the right. Within this frequency range 126, defined

between the lower frequency F1 and the higher frequency F2, it has been found that frequency spectrums representing by 122 and 124 are identifiable to particular persons. That is, a person A producing a frequency spectrum 122 shown in Figure 3A would differ from the frequency spectrum 124 made by a person B as shown in Figure 3B.

By digitally sampling each of the curves 122, 124, etcetera for different persons, a voice print can be developed and stored in the form of a template in a computer memory. Then, a second spectrum developed as a breath signature signal can be compared to a stored template to see if they substantially overlie. If they do, then the breath sample "passes". If they do not, the breath sample "fails".

This Invention, using the transducer described further below, measures the values of a breath sample's temperature, pressure and humidity, and integrates these values to produce a resultant single breath signature signal 32, which is stored as a template developed from digitally sampling the frequency spectrums 122, 124 etcetera developed as in Figure 3A and 3B. Either the frequency spectrum or the template developed from digitally sampling the frequency spectrum is then stored in memory for future comparison using subsequent breath samples. This becomes a voice print which can be used in the future to determine various characteristics of a breath sample.

Figure 4 shows Figure 1 expanded to illustrate the schematic structure described with respect to Figure 1. To facilitate easy correlation between Figures 4 and 1, the like structures of Figure 4 are numbered with the same numbers of Figure 1, and then augmented with A-D. For example, the Figure 1 memory 36 will become the Figure 4 separate memories 36A, 36B, 36C and 36D. This arrangement is provided in order to permit the four characteristics discussed regarding Table I to be coupled together and selectively developed.

To accomplish this, a few additional items of apparatus need to be added. To enable and disable the various sub-systems, a switch control 128 is connected through a line 130 to control the interactions among comparators 34A, 34B, 34C and 34D, as well as the interaction with interlock 44.

Line 130 is connected through the plurality of junctions 132A,

132B, 132C and 132D to a plurality of respective switches 134A-D. These in turn are each individually connected to each of three respective enabling devices 136A, 136B and 136C. The purpose of these enables is to successively test breath signature signal 32 according to the hierarchy described in Items 1-4 on Table I.

For example, if signal 32 passes the comparison within comparator 34A, the output signal is positive. Since the signal passed, it is routed through switch 134A to enable 136A, which in turn permits comparator 34B to receive incoming breath signature signal 32B. Thus, moving from left to right, the Table I Items 104 can be tested and sequenced, with each positive answer from the comparators causing the incoming signal 32 to successively undergo a more rigid test.

Memory 36B is shown as having four different "reference tables", one in each for the class of male, female, child and adult. These in turn are coupled to deliver their signals along a bus output signal 38B.

Figure 4 adds the concept that the breath signature signal 32 can be sent all the way through for storage in memory 78. Thus, memory 78 would record each signal 32 resulting from each breath test for future recall as desired.

In order for this Invention to work, it was necessary to identify and adapt a transducer capable of measuring the temperature, pressure and humidity of a breath sample, and then some form of apparatus for using these three pieces of information to produce the unique breath signature signals required. Preferably, a transducer was desired which could both measure these values as well as integrate together the measured values to produce the breath signature signal; such a transducer was found, identified by the registered trademark KYNAR brand Piezo Film.

Kynar is a trademark of the Pennwalt Corporation. This trademark is registered on the Principle Register maintained by the U.S. Patent and Trademark Office. The address of the trademark owner is: Pennwalt Corporation, KYNAR Piezo Film Group, 900 First Avenue, King of Prussia, PA, USA 19406.

This Kynar and Piezo Film (hereinafter "the film") is a polyvinylidine fluoride (PVDF) exhibiting very high piezoelectric and pyroelectric properties. It can be used to convert mechanical

deformation such as that induced by a pr ssure change of a breath sample, and convert a heat signal into an electrical signal, for example the heat contained in a breath sample. The film is produced as a thin sheet having metallized electrodes on both sides. Electricity conducting leads can be attached to the metallized electrodes for conducting a signal developed by the transducer film away for processing. Additional information about this product can be obtained from the trademark owner, who also designs and fabricates the film.

According to this Invention, the film is used as transducer 28 to (1) measure the temperature, pressure and humidity values in a breath sample, and then (2) integrate these values to produce a single output signal which is a unique breath signature signal for that particular breath sample. As previously described, this signature signal can be compared as desired against various references to (1) establish the validity of the sample, (2) distinguish the sample from those of other samples, (3) select one particular sample from a group of samples, and (4) recognize that a sample came from a particular identifiable person.

In order to obtain a breath sample containing a drug such as alcohol, it is preferably to measure what is commonly referred to as a "deep lung breath sample". That is, when exhaling a breath sample into sampler 22, the person can exhale for a second or two seconds before deep lung air begins being exhaled. As its name implies, deep lung breath comes from the interior remote portions of the lung, closer to the point of osmosis between the lung volume and the blood vessels interacting with the lung volume. For accurate measurement of a drug, a breath sample must come from deep within the lung.

A breath sample can be altered by having at least one of the temperature, pressure and the humidity altered. For example, the temperature of the gas coming from a compressed gas bottle would be below the range of temperatures commonly found in a human breath sample. This temperature variation means that the breath signature signal 32 produced in response to the gas sample would result in a "not valid" result in the comparator 34. Likewise, the gas pressure delivered by a gas bottle would be in excess of the pressure delivered by a human breath sample.

TABLE I. DETERMINATIONS RE BREATH SAMPLES

ITEM	INFORMATION RE BREATH SAMPLE	QUESTION	INFORMATION OBTAINED
1.	VALIDITY	Alter sample? (E.g., filter is desiccant)	Yes-No (Is/Is Not Valid)
2.	DISTINGUISH	Person's sex & age?	A. Male or Female & B. Child or Adult
3.	SELECT	Same person?	Yes-No (Is/Is Not Same Person)
4.	RECOGNIZE	Who gave the sample?	Person's Identity (It's Mr. _____)

Comments:

A. Moving from Item 1 downward towards Item 4 results in an increase in cost, technical complexity, and quality of intelligence gathered.

B. This Table I is hereby incorporated by reference into the Patent Application to which it is attached.

The above example embodiments discussed in the Detailed Description illustrate only a few of the constructions and methods made possible according to this Invention. It is to be understood that the following numbered Claims provide the scope and definition of the Invention.

WHAT IS CLAIMED IS:

1. An apparatus for generating a breath signature signal for a person who delivers a breath sample to a breath sampler means, the apparatus comprising: a transducer means, communicated with the breath sampler means, for sensing at least the temperature, the pressure and the humidity of the breath sample, and in response generating a breath signature signal which distinguishes the person from a plurality of persons.

2. The apparatus defined in claim 1, wherein the breath sample comprises: a deep lung breath sample.

3. The apparatus defined in claim 1, wherein the breath signature signal comprises: a frequency spectrum generated by the integration of at least the temperature, the pressure and the humidity of the breath sample.

4. The apparatus defined in claim 3, wherein: the integration is performed by the transducer.

5. The apparatus defined in claim 1, further including a validifier means for determining that the breath sample is delivered unaltered to the breath sampler, the validifier means comprising:
(a) a valid breath reference means for representing the valid common range of values of at least the temperature, the pressure and the humidity of the typical breath samples taken from a reference population of persons; and
(b) a comparator means, coupled to the valid breath reference means and the transducer means, for comparing the breath signal against the valid breath reference means to determine if the breath sample is valid.

6. The apparatus defined in claim 5, wherein the valid breath reference means comprises: a plurality of frequency spectrums produced by integrating at least the ranges of the values of the temperature, the pressure and the humidity of the breath samples form the reference population.

7. The apparatus defined in claim 5, wherein the valid breath reference means comprises: a plurality of templates developed from a plurality of frequency spectrums produced by integrating at least the pluralities of the range of values of the temperatures, the pressures and the humidities of the breath samples form the reference population.

8. The apparatus defined in claim 5, further including a distinguisher means for distinguishing, with respect to the person, both of (a) a male from a female, and (b) a child from an adult, the distinguisher means comprising:

(a) a separate class reference means for each of at least a group of four separate classes comprising respectively a plurality of males, females, children and adults, the class reference means containing at least the ranges of the temperatures, the pressures and the humidities of the typical breath samples characteristic of each of the classes; and

(b) the distinguisher means being coupled to the comparator means for comparing the class reference means with the breath sample of the person to identify the person as being both (1) one of a male and a female, and (2) one of a child and an adult.

9. The apparatus defined in claim 8, further including: a selector means for determining if a later breath sample was delivered by the same person who delivered an earlier breath sample, the selector means being communicated with the breath signature signal of both the earlier breath sample and the later breath sample for comparing the breath signatures to see if they are the same to thereby indicate that the same person one of (a) did and (b) did not deliver both breath samples.

10. The apparatus defined in claim 9, further including a recognition means for providing a positive identification of a person delivering a breath sample in the future, the recognition means comprising:

(a) a personal identification reference means, created by recording a specific breath signature signal produced by the transducer means in response to a specific breath sample delivered in the

present by each of a group of specific persons who are to be identified in the future according to the specific breath sample to be given in the future by each of the specific persons; and

(b) the comparator means being communicated to the personal identification reference means and the transducer means, for comparing each of the specific breath signature samples to the values stored in the personal identification reference means, to confirm one of (1) the same person delivered both of the present and the future breath samples and (2) the same person did not deliver both of the present and the future breath samples.

11. The apparatus defined in claim 1, further including: a sensing means, communicated to the breath sampler means, for detecting the presence of a drug in the breath sample.

12. The apparatus defined in claim 11, wherein the drug comprises: an alcohol.

13. An apparatus for sensing the removal of at least a portion of a drug content of a breath sample delivered to a breath sampler means by a person, the apparatus comprising:

(a) a transducer means, communicated with the breath sampler means, for responding to at least the temperature, the pressure and the humidity of the breath sample, which may contain a drug, and in response generating a breath signature signal;

(b) a valid breath reference means, for representing the valid common range of values of the combination of at least the temperature, the pressure and the humidity of the typical breath samples not containing a drug and taken from a reference population of a plurality of persons; and

(c) a comparator means, coupled to the breath reference means and the transducer means, for comparing the breath signature signal against the valid breath reference means, to determine one of (1) the breath sample is valid because the breath signature signal substantially matches the values in the reference means, and (2) the breath sample is invalid because the breath signature does not substantially match the values in the reference means.

14. The apparatus defined in claim 13, wherein the drug comprises: an alcohol.

15. The apparatus defined in claim 13, wherein the invalid breath sample comprises: a breath sample that has been altered by having at least one of the temperature, the pressure and the humidity altered.

16. The apparatus defined in claim 13, wherein the response by the transducer means comprises: a breath signature signal in the form of a frequency spectrum produced by the integration by the transducer means of the values of the temperature, the pressure and the humidity measured by the transducer means.

17. An apparatus for generating a breath signature of a person, the apparatus comprising:

(a) a sampler means, for accepting a breath sample from the person; and

(b) a transducer means, communicated with the sampler means, for sensing at least the temperature, the pressure and the humidity of the breath sample, and in response generating a breath signature signal which is unique to the person.

18. The apparatus defined in claim 17, wherein the sampler means comprises: a sealed chamber communicated to a mouthpiece.

19. The apparatus defined in claim 17, wherein the breath sample comprises: a deep lung breath sample.

20. The apparatus defined in claim 17, wherein the breath signature signal comprises: a frequency spectrum generated by integration of at least the temperature, the pressure and the humidity.

21. The apparatus defined in claim 20, wherein: the integration is performed by the transducer.

22. An apparatus for generating a breath signature of a person, the apparatus comprising:

(a) a sampler means, for accepting a deep lung breath sample from the person; and

(b) a transducer means, placed in fluid communication with the sampler means, for measuring at least the temperature, the pressure and the humidity of the breath sample, and in response generating a breath signature signal being in the form of a frequency spectrum produced by the integration by the transducer means of at least the temperature, the pressure and the humidity of the breath sample.

23. A method for generating a breath signature of a person, the method comprising the steps of:

(a) sampling the breath of the person; and

(b) transducing at least the temperature, the pressure and the humidity of the breath sample into a breath signature signal unique to the person.

24. The method defined in claim 23, wherein the sampling step comprises: sampling a deep lung breath sample.

25. The method defined in claim 23, wherein the transducing step comprises: integrating the temperature, the pressure and the humidity to produce the breath signature signal.

26. The method defined in claim 25, wherein the integrating step comprises: producing a breath signature signal in the form of a frequency spectrum.

27. The method defined in claim 25, wherein the producing the breath signature signal step comprises: employing a transducer to perform the integrating step.

28. An apparatus for determining that a breath sample exhaled by a person is delivered unaltered to a breath sampler, the apparatus comprising:

(a) a human breath reference means, for representing the common range of values of at least the temperature, the pressure and the humidity of the typical breath samples taken from a reference

population of persons;

(b) a transducer means, communicated with the breath sampler, for sensing at least the temperature, the pressure and the humidity of the breath sample from the person, and in response generating a breath signal; and

(c) a comparator means, coupled to the human breath reference means and the transducer means, for comparing the breath signal against the human breath reference means to verify one of (1) the breath sample did come from a person, and (2) the breath sample did not come from a person.

29. The apparatus defined in claim 28, wherein the breath sampler comprises: an enclosed chamber having a mouthpiece for admitting the breath sample.

30. The apparatus defined in claim 28, wherein the breath reference means comprises: a plurality of frequency spectrums produced by integrating at least the range of the values of the temperature, the pressure and the humidity of the breath samples from the reference population.

31. The apparatus defined in claim 28, wherein the breath reference means comprises: a plurality of templates developed from a plurality of frequency spectrums produced by integrating at least the range of values of the temperature, the pressure and the humidity of the breath samples from the reference population.

32. The apparatus defined in claim 28, further including: a distinguisher means for distinguishing, with respect to the person, both of (a) a male from a female, and (b) a child from an adult, the distinguisher means having a separate class reference means for each of at least a group of four separate classes comprising respectively a plurality of males, females, children and adults, the class reference means containing at least the ranges of the temperatures, the pressures and the humidities of the typical breath samples characteristic of each of the classes, the distinguisher means being coupled to the comparator means for comparing the class reference means with the breath sample of the person, to identify the person

as being both (a) one of a male and a female, and (2) one of a child and an adult.

33. A method for determining that a breath sample exhaled by a person is delivered unaltered to a breath sampler, the method comprising the steps of:

(a) representing, in a breath reference means, the common range of values of at least the temperature, the pressure and the humidity of the typical breath samples taken from a reference population of persons;

(b) measuring the values of at least the temperature, the pressure and the humidity of the breath sample;

(c) deriving a breath signal which is characteristic of the particular values of the temperature, the pressure and the humidity of the breath sample; and

(d) comparing the breath sign to the breath reference means to determine if the breath sample came directly from the person to the breath sampler.

34. An apparatus for distinguishing both of (i) a male from a female and (ii) a child from an adult, by measuring with a breath sampler means a plurality of breath samples from a reference population which includes each of a class of males, females, children and adults, the apparatus comprising:

(a) a separate breath reference means for each of the classes, containing at least the temperatures, the pressures and the humidities of the typical breath samples characteristic of each of the classes:

(b) a transducer means, communicated with the breath sampler, for sensing at least the temperature, the pressure and the humidity of the breath sample taken from the particular person who is to be identified as being (i) one of a male and a female, and (ii) one of a child and an adult; and

(c) a comparator means, coupled to the transducer means and to each of the separate breath reference means, for comparing the breath sample of the particular person to each of the separate breath reference means, to identify the person as being (i) one of a male and a female, and (ii) one of a child and an adult.

35. The apparatus defined in claim 34, further including: a selector means for determining if a later breath sample was delivered by the same person who delivered an earlier breath sample, the selector means being communicated with the breath signature signals of both the earlier breath sample and the later breath sample, for comparing the signatures to see if they are the same to thereby indicate that the same person one of (a) did and (b) did not deliver both of the breath samples.

36. The apparatus defined in claim 35, further including: a recognition means for providing a positive identification of the person delivering the breath sample, the recognition means including a personal identification reference means containing a breath signature signal produced in the present by the transducer means for each of the persons whose breath is to be sampled in the future, the recognition means being coupled to the comparator means for the comparator means to compare each of the future breath samples to the recognition means for positively identifying in the future the person who provided the breath sample in the present.

37. A method using a breath sample for distinguishing both of (a) a male from a female and (b) a child from an adult, the method comprising the steps of:

(a) developing a reference means for each of the classes, derived from at least the temperatures, the pressures and the humidities of the typical breath samples characteristics of each of the classes;

(b) transducing at least the temperature, the pressure and the humidity of the breath sample taken from the person who is to be identified as being (1) one of a male and a female, and (2) one of a child and an adult; and

(c) comparing the result of step (b) to the reference means of step (a) to distinguish the person as being both (1) one of a male and a female, and (2) one of a child and an adult.

38. The method defined in claim 37, further including the step of: selecting to determine if a later breath sample is delivered by the same person who delivered an earlier breath sample by comparing the two breath signature signals to each other.

39. The method defined in claim 38, further including the step of: recognizing a particular person in the future, by comparing the breath signature signal of the particular person in the future, against a person identification reference means containing a breath signature signal produced in the present by the transducer means for each of the persons whose breath is to be sampled in the future.

AMENDED CLAIMS
[received by the International Bureau on 25 February 1987 (25.02.87); original claims 1,3 17, 20 22, 23,25,26 and 30 amended; other claims unchanged (4 pages)]

1. (Once Amended) An apparatus for generating a breath signature signal for a person who delivers a breath sample to a breath sampler means, the apparatus comprising: a transducer means, communicated with the breath sampler means, for sensing at least each of the temperature, the pressure and the humidity of a single breath sample, and in response generating a breath signature signal which distinguishes the person from a plurality of persons.

2. The apparatus defined in claim 1, wherein the breath sample comprises: a deep lung breath sample.

3. (Once Amended) The apparatus defined in claim 1, wherein the breath signature signal comprises: a single frequency spectrum generated by the simultaneous integration of at least each of the temperature, the pressure and the humidity of the breath sample.

4. The apparatus defined in claim 3, wherein: the integration is performed by the transducer.

5. The apparatus defined in claim 1, further including a validifier means for determining that the breath sample is delivered unaltered to the breath sampler, the validifier means comprising:
(a) a valid breath reference means for representing the valid common range of values of at least the temperature, the pressure and the humidity of the typical breath samples taken from a reference population of persons; and
(b) a comparator means, coupled to the valid breath reference means and the transducer means, for comparing the breath signal against the valid breath reference means to determine if the breath sample is valid.

6. The apparatus defined in claim 5, wherein the valid breath reference means comprises: a plurality of frequency spectrums produced by integrating at least the ranges of the values of the temperature, the pressure and the humidity of the breath samples

14. The apparatus defined in claim 13, wherein the drug comprises: an alcohol.

15. The apparatus defined in claim 13, wherein the invalid breath sample comprises: a breath sample that has been altered by having at least one of the temperature, the pressure and the humidity altered.

16. The apparatus defined in claim 13, wherein the response by the transducer means comprises: a breath signature signal in the form of a frequency spectrum produced by the integration by the transducer means of the values of the temperature, the pressure and the humidity measured by the transducer means.

17. (Once Amended) An apparatus for generating a single breath signature of a person, the apparatus comprising:

(a) a sampler means, for accepting a single breath sample from the person; and

(b) a transducer means, communicated with the sampler means, for sensing at least each of the temperature, the pressure and the humidity of the single breath sample, and in response generating a single integrated breath signature signal which is unique to the person.

18. The apparatus defined in claim 17, wherein the sampler means comprises: a sealed chamber communicated to a mouthpiece.

19. The apparatus defined in claim 17, wherein the breath sample comprises: a deep lung breath sample.

20. (Once Amended) The apparatus defined in claim 17, wherein the breath signature signal comprises: a frequency spectrum generated by the simultaneous integration of at least each of the temperature, the pressure and the humidity.

21. The apparatus defined in claim 20, wherein: the integration is performed by the transducer.

22. (Once Amended) An apparatus for generating a breath signature of a person, the apparatus comprising:

(a) a sampler means, for accepting a deep lung breath sample from the person; and

(b) a transducer means, placed in fluid communication with the sampler means, for simultaneously measuring at least each of the temperature, the pressure and the humidity of the breath sample, and in response generating a single integrated breath signature signal being in the form of a frequency spectrum produced by the simultaneous integration by the transducer means of at least each of the temperature, the pressure and the humidity of the breath sample.

23. (Once Amended) A method for generating a breath signature of a person, the method comprising the steps of:

(a) sampling the breath of the person; and

(b) transducing simultaneously at least each of the temperature, the pressure and the humidity of the breath sample into a single breath signature signal unique to the person.

24. The method defined in claim 23, wherein the sampling step comprises: sampling a deep lung breath sample.

25. (Once Amended) The method defined in claim 23, wherein the transducing step comprises: integrating each of the temperature, the pressure and the humidity to produce the single integrated breath signature signal.

26. (Once Amended) The method defined in claim 25, wherein the integrating step comprises: producing a single breath signature signal in the form of a frequency spectrum developed from the simultaneous integration of each of the temperature, the pressure and the humidity.

27. The method defined in claim 25, wherein the producing the breath signature signal step comprises: employing a transducer to perform the integrating step.

28. An apparatus for determining that a br ath sample exhaled by a person is delivered unaltered to a breath sampler, the apparatus comprising:

(a) a human breath reference means, for representing the common range of values of at least the temperature, the pressure and the humidity of the typical breath samples taken from a reference population of persons;

(b) a transducer means, communicated with the breath sampler, for sensing at least the temperature, the pressure and the humidity of the breath sample from the person, and in response generating a breath signal; and

(c) a comparator means, coupled to the human breath reference means and the transducer means, for comparing the breath signal against the human breath reference means to verify one of (1) the breath sample did come from a person, and (2) the breath sample did not come from a person.

29. The apparatus defined in claim 28, wherein the breath sampler comprises: an enclosed chamber having a mouthpiece for admitting the breath sample.

30. (Once Amended) The apparatus defined in claim 28, wherein the breath reference means comprises: a plurality of frequency spectrums produced by integrating at least the range of the values of the temperature, the pressure and the humidity of the breath samples from the reference population.

31. The apparatus defined in claim 28, wherein the breath reference means comprises: a plurality of templates developed from a plurality of frequency spectrums produced by integrating at least the range of values of the temperature, the pressure and the humidity of the breath samples from the reference population.

32. The apparatus defined in claim 28, further including: a distinguisher means for distinguishing, with respect to the person, both of (a) a male from a female, and (b) a child from an adult, the distinguisher means having a separate class reference means for

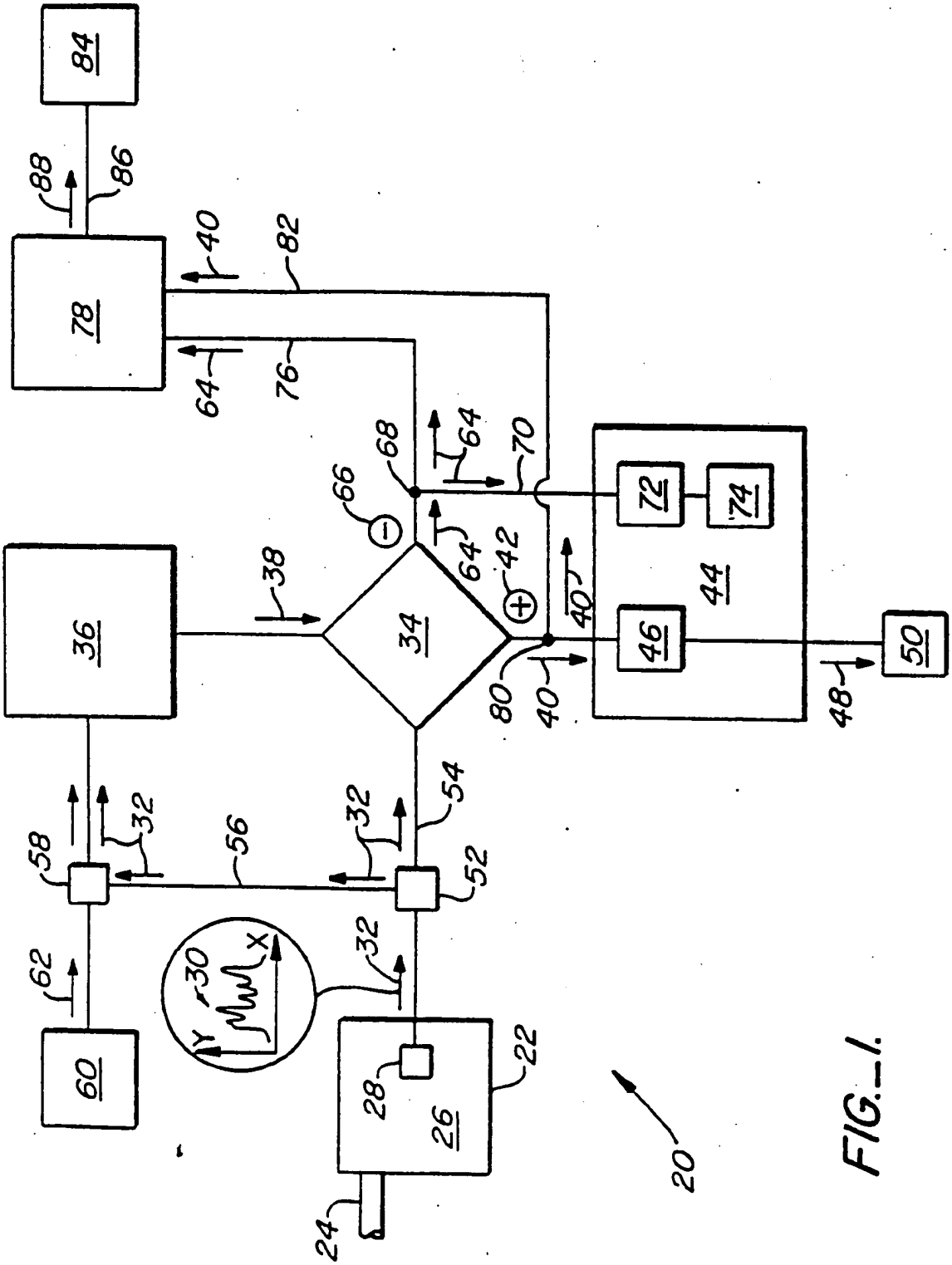
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FIG._1.

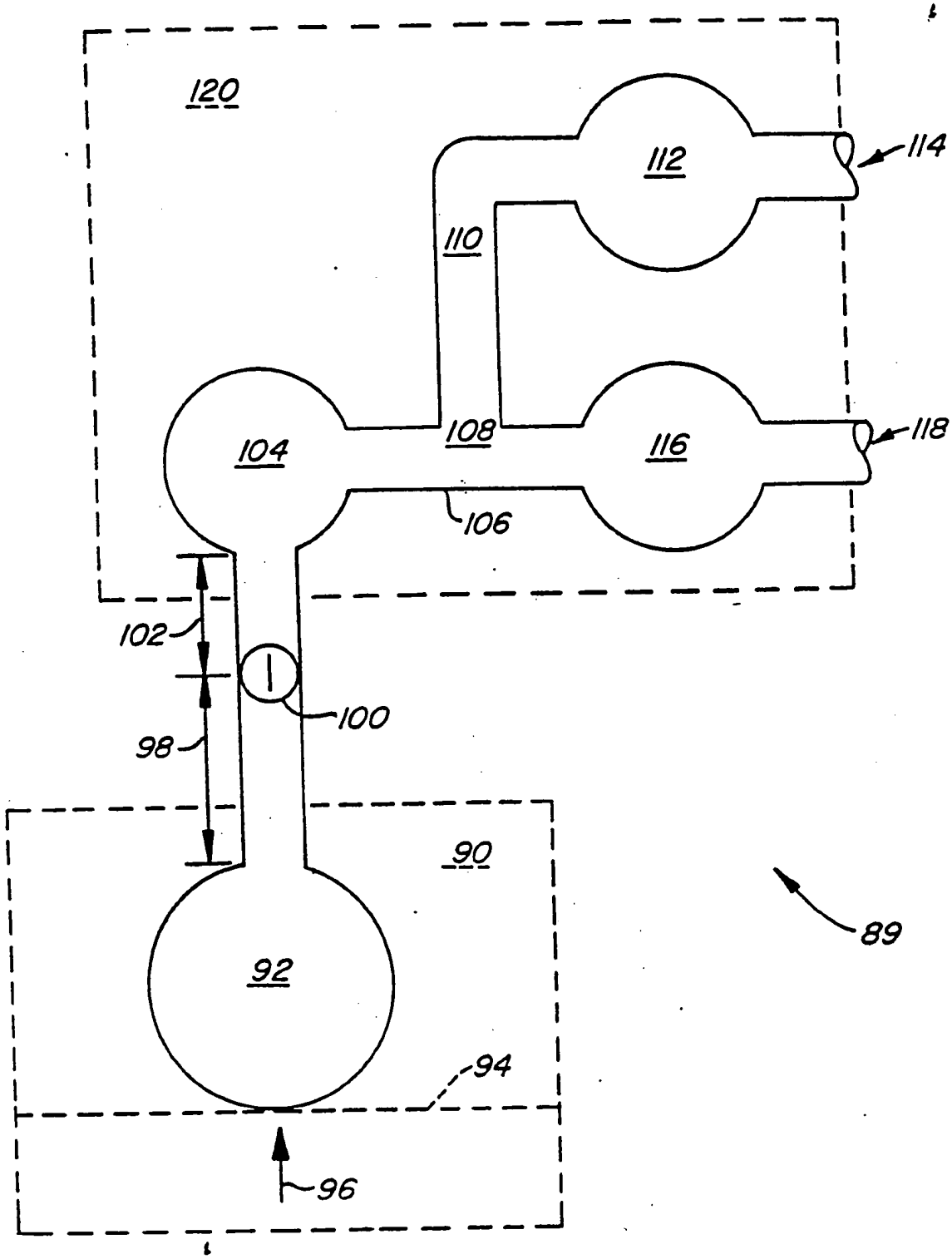

FIG._2.

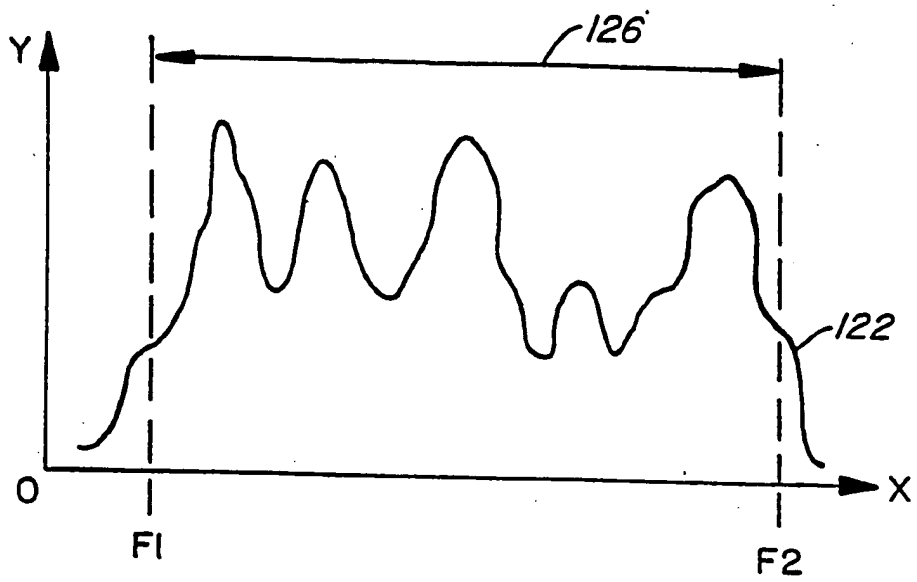

FIG._3A.

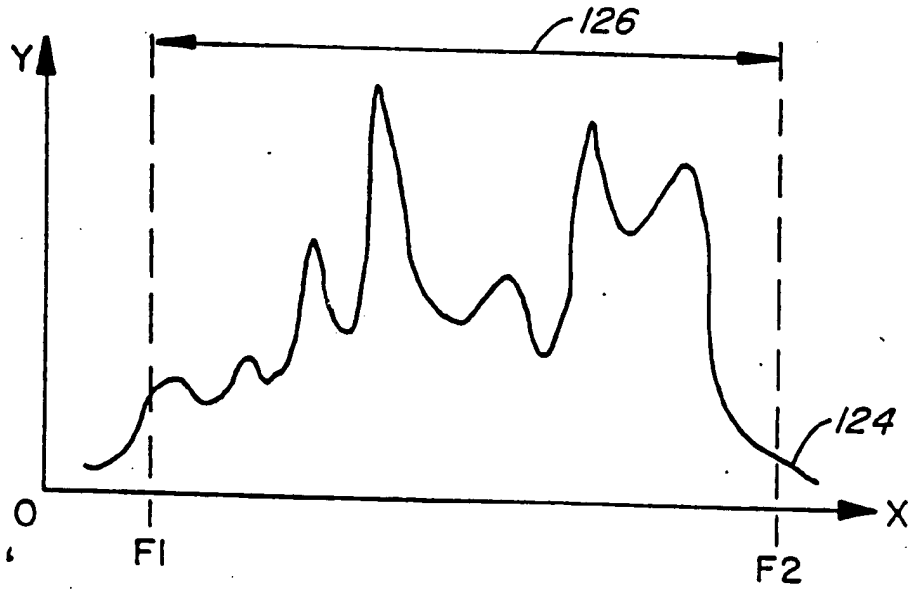

FIG._3B.

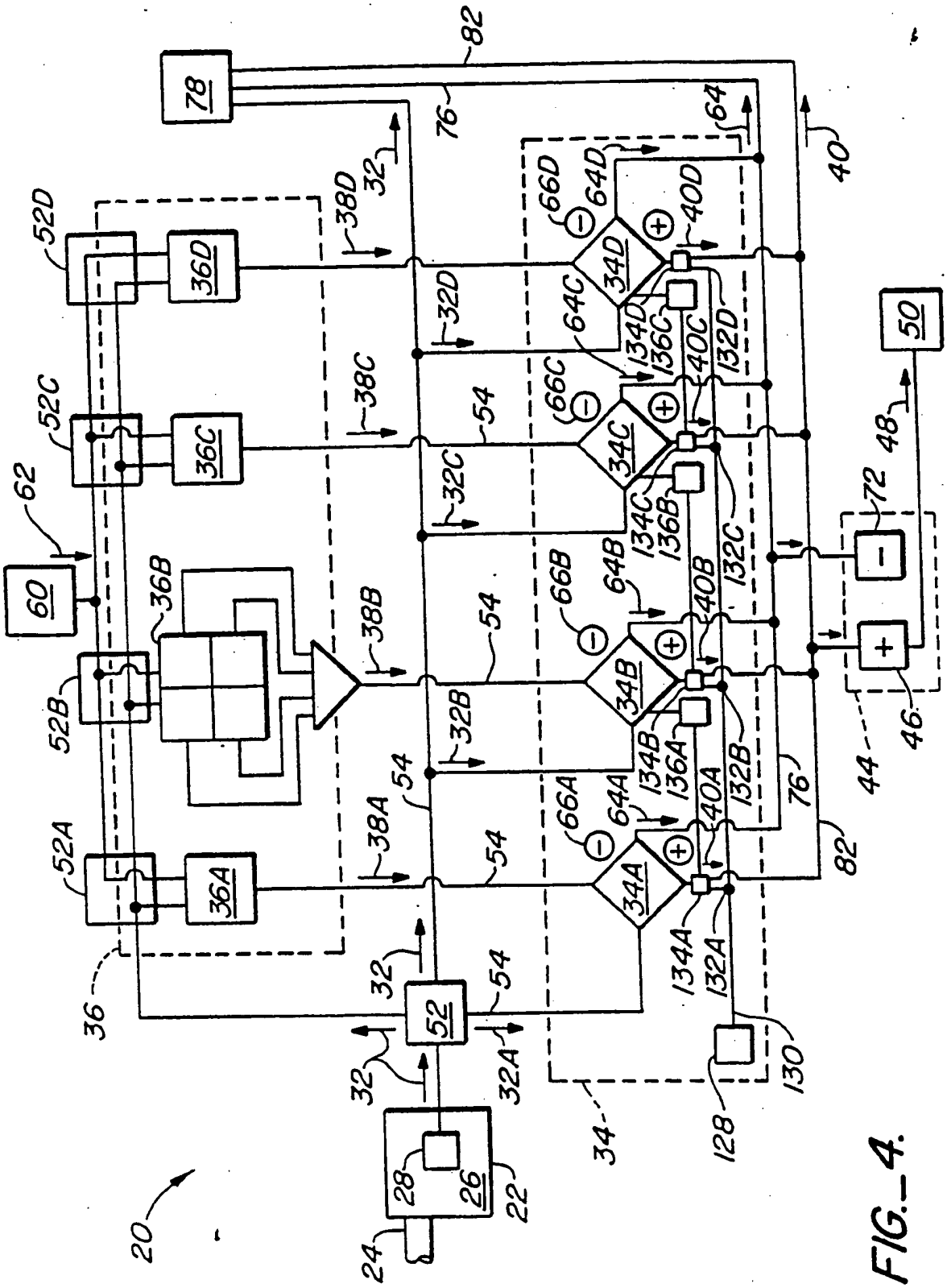
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FIG._4.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US86/02230

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): G01N 33/00
U.S. Cl. 436/132

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	73/23,27R,593,659; 128/716,719,720,724 340/576; 422/84; 436/132

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y,P	U.S., A, 4,608,995 (Linnarsson et al) 02 September 1986, See column 4 lines 17-32	1,17,22,23
Y	U.S., A, 3,842,663 (Harting et al) 22 October 1974 See the entire document	3,20,26,30
A	U.S., A, 4,399,684 (Advani et al) 23 August 1983	
A	U.S., A, 4,317,453 (Heim et al) 02 March 1982	
A	U.S., A, 4,316,380 (Heim et al) 23 February 1982	
A	U.S., A, 4,248,245 (Kempin) 03 February 1981	
A	U.S., A, 4,093,945 (Collier et al) 06 June 1978	
A	U.S., A, 3,831,707 (Takeuchi) 27 August 1974	

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
04 December 1986	08 DEC 1986
International Searching Authority [1]	Signature of Authorized Officer [20]
ISA/US	Michael S. Gaybowski